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PATENT ABSTRACTS OF JAPAN

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(54) ALUMINUM ALLOY BRAZING FIN MATERIAL FOR HEAT EXCHANGER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an aluminum alloy brazing fin material for an automobile heat exchanger using an aluminum tubular body in which a Zn covering layer is formed and subjected to no chromate treatment, whose formability is excellent, and in which the generation of pitting corrosion in the aluminum tubular body is suppressed in a severe corrosive environment, further, the corrosion resistance of a brazed part is excellent, and the departure of a fin from the aluminum tubular body can be prevented.

SOLUTION: The aluminum alloy brazing fin material is obtained by cladding an Al-Si-based alloy brazing filler metal on both the sides of a core material. The core material is composed of an aluminum alloy comprising 0.8 to 2.5% Mn, 0.1 to 1.0% Si, 0.06 to 0.3% Fe and 0.8 to 4.0% Zn, and the balance Al with impurities. The brazing filler metal is composed of an aluminum alloy comprising 6 to 13% Si and 0.06 to 0.4% Cu, and the balance Al with impurities. The brazing filler metal is clad on both the sides of

the core material, respectively, at a thickness of 3 to 20% to the whole thickness.

CLAIMS

[Claim(s)]

[Claim 1]

It is an aluminum alloy blazing fin material attached to Zn covering aluminium-pipe object which carries out the clad of the aluminum-Si system alloy wax material to both sides of a core material, and constitutes a working-fluid passage by soldering, Said core material Mn:0.8-2.5% (it is [mass % and the following] the same), Si:0.1-1.0%, Fe: 0.06-0.3%, Zn : With an aluminum alloy which consists of remainder aluminum and an impurity, contain 0.8 to 4.0%, and it is constituted, and said wax material, Si: 6-13%, Cu: An aluminum alloy blazing fin material for heat exchangers, wherein it contains 0.06 to 0.4%, it comprises an aluminum alloy which consists of remainder aluminum and an impurity and the clad of the wax material is carried out to both sides of a core material by 3 to 20% of thickness of whole thickness, respectively.

[Claim 2]

The aluminum alloy blazing fin material for heat exchangers according to claim 1, wherein said core material contains 1 of Zr:0.05-0.3%, Cr:0.05-0.3%, and Ti:0.05-0.3% of sorts, and two sorts or more further.

[Claim 3]

The aluminum alloy blazing fin material for heat exchangers according to claim 1 or 2 with which tensile strength is characterized by a difference of 180 - 250MPa, tensile strength, and proof stress being 20 or less MPa.

[Claim 4]

When the amount of Cu(s) in wax material is made [Zn coating weight of said Zn covering aluminium-pipe object] into C % for the amount of Zn in A (g/m^2) and a core material of said fin material B%, -The aluminum alloy blazing fin material for heat exchangers according to any one of claims 1 to 3 which satisfies a relation of 100 <=-10xA+23xB-106xC<=20, and is characterized by a difference of rest potential of an inner periphery of said aluminium-pipe object and rest potential of a fin being not less than 80 mV.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention]
[0001]
this invention -- the aluminum alloy blazing fin material for heat exchangers -- in detail, Like a radiator, a heater core, an oil cooler, an intercooler, the capacitor of a car air-conditioner, and an evaporator, soldering junction of the aluminium-pipe object (an aluminum alloy shell is included) which constitutes a fin and a working-fluid passage is carried out.
Therefore, it is related with the aluminum alloy blazing fin material for aluminum alloy made heat exchangers formed, especially the aluminum alloy blazing fin material excellent in the corrosion resistance of a fillet.

[Background of the Invention]
[0002]
The aluminum alloy made heat exchanger is widely used as heat exchangers for cars, such as an evaporator of a radiator, a heater core, an oil cooler, an intercooler, and a car air-conditioner, and a capacitor. These aluminum alloy made heat exchangers A pure aluminium system, an aluminum-Cu system alloy, On the surface of aluminium-pipe objects (working-fluid passage material), such as an extrusion flattened tube which consists of an aluminum-Mn system alloy, an aluminum-Mn-Cu system alloy, etc. The fin which fabricated the brazing sheet which carried out the clad of the aluminum-Si system alloy wax material to the core material of the aluminum-Mn system alloy of JIS A3003 and JISA3203 grade wavelike, It is assembled by attaching by flux soldering which uses chloride system flux, inert gas atmosphere soldering using fluoride system flux, or vacuum soldering.
[0003]
Pitting peculiar to an aluminum material arises on an aluminium-pipe object, and the aluminum alloy made heat exchanger for cars has the problem that pitting reaches to the inside of a shell and a heat exchange function loses, when used in a cruel environment. In order to solve this problem, the material which formed Zn (Zn alloy is included) enveloping layer **** to the Electrochemistry Sub-Division target in the surface of an aluminium-pipe object from the aluminium-pipe object, and made potential on the surface of a shell ** from the aluminium-pipe inside-of-the-body part is used, and the technique of carrying out soldering junction of the fin is adopted

on it.

[0004]

Usually, although Zn enveloping layer is formed in the surface of aluminium-pipe objects, such as an aluminum flattened tube by which extrusion molding was carried out, by carrying out thermal spraying of Zn or the Zn alloy (refer to patent documents 1), When soldering junction of the fin material which becomes the aluminium-pipe object which carried out flame spraying of the Zn from blazing was carried out and the heat exchanger for cars is produced, The fillet part of an aluminium-pipe object and a fin corrodes, and although the corrosion of a fin is slight, the problem that an aluminium-pipe object and a fin dissociate and the heat transfer performance of a heat exchanger falls may arise.

[0005]

the dust by which it was generated with the spike tire of the car on the other hand in recent years -- health top damage -- ****** -- the studless tire being used instead of the spike tire, in order to be anxious about things, but. Since a studless tire is inferior to the braking performance in a freezing road surface, at the time of the snow cover of winter, and road surface freezing, sprinkling snow melting agents, such as a calcium chloride and sodium chloride, in large quantities on a road surface at a road surface for slip accident prevention of a car is performed. In order for these snow melting agents to adhere to the heat exchanger of the car under run and to promote the corrosion of a heat exchanger, it dissociates at an early stage, and an aluminium-pipe object and a fin also produce the problem that a fin falls out, in being cruel.

[0006]

Although a heat exchanger is painted after soldering, in order that it might improve the adhesion of a coat and might raise corrosion resistance, chromic acid chromate and phosphoric acid chromate treatment were performed to the surface of the aluminum member which constitutes a heat exchanger, but. In order to abolish chromate treatment from an environmental problem, advance of the corrosion of a fillet is easy to separate a fin early from an aluminium-pipe object increasingly.

[Patent documents 1] JP,H2-138455,A

[Description of the Invention]

[Problem(s) to be Solved by the Invention]

[0007]

In order that artificers may solve this problem, as a result of examining many things, when carrying out soldering junction of the fin material at the aluminium-pipe object

which carried out flame spraying of the Zn, Zn is spread in the fillet part of an aluminium-pipe object and a fin, It turned out that a fillet part becomes the Electrochemistry Sub-Division target with ** from an aluminium-pipe object and a fin, therefore a fillet part carries out priority corrosion. If especially diffusion of Zn to a fillet part lessens quantity of becoming remarkable and Zn by which flame spraying is carried out when there is much Zn coating weight of an enveloping layer as a result of adding test examination furthermore, a certain amount of corrosion-resistant improvement will be obtained, but. It found out the presentation of the Zn layer covered by that the not necessarily outstanding corrosion resistance cannot be acquired only by lessening coating weight of Zn, an aluminium-pipe object, a fin material, and the aluminium-pipe object, and that these combination influenced the corrosion resistance of a heat exchanger.

[0008]

this invention is made based on the above-mentioned knowledge, and comes out. It is an aluminum alloy blazing fin material for the heat exchangers for cars which the purpose uses the aluminium-pipe object in which Zn enveloping layer was formed, and does not perform chromate treatment, While excelling in a moldability and controlling pitting generating of an aluminium-pipe object under cruel corrosive environment, it excels in the corrosion resistance of a soldering part, and is in providing the aluminum alloy blazing fin material for heat exchangers which can prevent a fin from seceding from an aluminium-pipe object.

[Means for Solving the Problem]

[0009]

An aluminum alloy blazing fin material for heat exchangers by Claim 1 of this invention for attaining the above-mentioned purpose, It is an aluminum alloy blazing fin material attached to Zn covering aluminium-pipe object which carries out the clad of the aluminum-Si system alloy wax material to both sides of a core material, and constitutes a working-fluid passage by soldering, Said core material Mn:0.8-2.5%, Si:0.1-1.0%, Fe:0.06-0.3%, Zn : With an aluminum alloy which consists of remainder aluminum and an impurity, contain 0.8 to 4.0%, and it is constituted, and said wax material, Si: 6-13%, Cu: 0.06 to 0.4% is contained, it comprises an aluminum alloy which consists of remainder aluminum and an impurity, and the clad of the wax material is carried out to both sides of a core material by 3 to 20% of thickness of whole thickness. respectively.

[0010]

In Claim 1, as for an aluminum alloy blazing fin material for heat exchangers by Claim 2, said core material contains 1 of Zr:0.05-0.3%, Cr:0.05-0.3%, and Ti:0.05-0.3% of sorts, and two sorts or more further.

[0011]

An aluminum alloy blazing fin material for heat exchangers by Claim 3 is characterized by tensile strength being [a difference of 180 - 250MPa, tensile strength, and proof stress] 20 or less MPa in Claim 1 or 2.

[0012]

An aluminum alloy blazing fin material for heat exchangers by Claim 4, When the amount of Cu(s) in wax material is made [Zn coating weight of said Zn covering aluminium-pipe object] into C % for the amount of Zn in A (g/m^2) and a core material of said fin material B% in either of the Claims 1-3, -A relation of 100 <=-10xA+23xB-106xC<=20 is satisfied, and it is characterized by a difference of rest potential of an inner periphery of said aluminium-pipe object and rest potential of a fin being not less than 80 mV.

[Effect of the Invention]

[0013]

According to this invention, profit which is excellent in a moldability and makes it possible to prevent the priority corrosion of a fillet is provided with 100 micrometers of the following (0.10 mm) aluminum alloy blazing fin materials for heat exchangers for thickness. By using the aluminum alloy blazing fin material concerned, Since the problem which a fin separates from an aluminium-pipe object is solved and the sacrificial anode effect of a fin and the anticorrosive effect of an aluminium-pipe body surface are also fully demonstrated even if a heat exchanger is placed under corrosive environment, reinforcement of a heat exchanger can be attained.

[Best Mode of Carrying Out the Invention]

[0014]

(1) alloy content in the aluminum alloy blazing fin material for heat exchangers of this invention, the rate of a clad of (2) wax material, (3) mechanical properties, and (4) potential difference are explained.

[0015]

(1) Alloy content

Hereafter, the meaning and its Reason for limitation of the alloy content in this invention are explained.

(Core material)

Mn in a core material raises the intensity of a core material, and functions as

improving elevated-temperature-proof buckling nature. The desirable content range of Mn is 0.8 to 2.5%, at less than 0.8%, the effect is small, if contained exceeding 2.5%, crystallized material big and rough at the time of casting will generate, strip-processing nature will be injured, and it will become difficult to manufacture it of a plate. The still more desirable content of Mn is 1.0 to 1.7%.

[0016]

Fe in a core material coexists with Mn, and raises the intensity of the fin material before soldering and after soldering. The desirable content of Fe is 0.06 to 0.3% of range, the effect is small at less than 0.06%, if 0.3% is exceeded, a crystal grain will become fine, it will become easy to corrode a melting wax in a core material, elevated-temperature-proof buckling nature will fall, and self-corrosiveness will increase. The still more desirable content of Fe is 0.06 to 0.25% of range.

[0017]

It decreases the amount of dissolution of Mn and raises thermal conductivity (electrical conductivity) while Si in a core material combines with Mn, generates a detailed aluminum-Mn-Si system compound and raises the intensity of a fin material. Since it controls that Si of wax material is spread in a core material, sufficient fillet can be formed. The desirable content range of Si is 0.1 to 1.0%, and is not enough as the effect, and if 1.0% is exceeded, it exists in a grain boundary mostly, and in order to make the field where Si concentration is low form near the grain boundary, it will become easy to produce intergranular corrosion. [of less than 0.1%] The still more desirable content of Si is 0.3 to 0.7% of range.

[0018]

Zn in a core material makes potential of a core material **, and heightens a sacrificial anode effect. The desirable content range of Zn will be 0.8 to 4.0%, and at less than 0.8%, the effect is small, and if contained exceeding 4.0%, the self corrosion resistance of the core material itself will worsen, and will also increase grain boundary corrosion sensitivity. The still more desirable content of Zn is 1.5 to 3.0% of range.

[0019]

Zr, Cr, and Ti in a core material improve elevated-temperature buckling nature while raising the intensity of the fin material before soldering and after soldering. Both the desirable content ranges of Zr, Cr, and Ti are 0.05 to 0.3%, at less than 0.05%, the effect is small, if contained exceeding 0.3%, crystallized material big and rough at the time of casting will generate them, they will injure strip-processing nature, and it will become difficult to manufacture them of a plate.

[0020]

Into a core material, 0.3% or less of In, Sn, and Ga may be added, respectively, and each of these elements makes potential **, without reducing most thermal conductivity of a fin material, and gives a sacrificial anode effect. Even if 0.1% or less of Pb, Li, Sr, Ca, and Na contain, the effect of this invention is not injured. For improving strength, 0.1% or less of Be can also be added for 0.3% or less of V, Mo, nickel, and antioxidizing, respectively.
[0021]
(Wax material)
Si in wax material lowers the melting point of wax material, and functions as improving the mobility of a melting wax. The desirable content range of Si will be 6 to 13%, at less than 6%, the effect is small, if 13% is exceeded, the melting point will become high rapidly and the processability at the time of manufacture will also fall. The still more desirable content of Si is 7 to 12% of range.
[0022]
Cu in wax material functions as making potential of the fillet after soldering into **. The desirable content range of Cu will be 0.06 to 0.4%, at less than 0.06%, the effect is small, if 0.4% is exceeded, the potential of the fin itself will also serve as **, therefore a sacrificial anode effect will fall. Self corrosion resistance falls and it becomes easy to produce intergranular corrosion. The still more desirable content of Cu is 0.1 to 0.3%.
[0023]
Into wax material, even if 0.1% or less of Pb, Li, and Ca are contained, respectively, the effect of this invention is not spoiled [0.3% or less of Cr, Mn, and], respectively. For the minuteness making of cast structure, for the minuteness making of the Si grain in 0.3% or less of Ti, 0.01% or less of B, and wax material, In order to make low 0.1% or less of Sr, Na, and potential, respectively, to give a sacrificial anode effect, to control 0.1% or less of In, Sn, Ga, and the scaling growth of anodic oxide film, respectively and to raise the mobility of 0.1% or less of Be, and wax material, 0.4% or less of Bi can also be added
[0024]
As for Fe in wax material, since it will become easy to produce self-corrosion if contained so much, restricting to 0.8% or less is desirable. When applying inert atmosphere soldering which uses the flux of a fluoride system, in order that Mg in wax material may react to the flux of a fluoride system and may check soldering nature, restricting to 0.5% or less is preferred.
[0025]

(Rate of a clad of wax material)
As for the rate of a clad of the wax material in a fin material, in the following (0.10 mm) fin materials, it is preferred to consider it as an average of 3 to 20% on one side 100 micrometers in thickness. In less than 3%, it becomes the thickness of the wax material by which a clad is carried out to a core material is too small, and the uniform rate of a clad is difficult to get, and difficult to manufacture [by which the clad was carried out in wax material] the rate of a clad of one side of a fin material. If 20% is exceeded, while becoming that a core material dissolves [increase / too much / the amount of melting of a wax], and it is easy to corrode, since board thickness becomes thin, intensity falls. The still more desirable rate of a clad is 5 to 15%.
[0026]
(Mechanical properties)
The aluminum alloy blazing fin material for heat exchangers of this invention has the tensile strength of the fin material (raw material) before shaping within the limits of 180 - 250MPa, and it is important for it that the value of (tensile strength-proof stress) is 20 or less MPa. By making the tensile strength of the fin material before shaping, and the value of (tensile strength-proof stress) into the above-mentioned range, it excels in a moldability and the variation in the fin crest height at the time of corrugated shaping can be abolished.
[0027]
If it is easy to carry out abnormal deformation of the tensile strength of a raw material by the working stress at the time of corrugated shaping in less than 180 MPa, the variation in fin crest height becomes large and the tensile strength of a raw material exceeds 250MPa, The springback at the time of corrugated shaping becomes large, and the variation in fin crest height becomes large, and also when it is any, it becomes easy to produce defecting joining between a fin and an aluminium-pipe object at the time of soldering. In order to carry out tensile strength of a raw material within the limits of 180 - 250MPa and for the value of (tensile strength-proof stress) to set to 20 or less MPa, the technique of adjusting the homogenization temperature at the time of fin material manufacture, annealing process temperature, and the workability of cold rolling can be used.
[0028]
In the aluminum alloy blazing fin material for heat exchangers of this invention, it is preferred to make the matrix of a raw material into fiber texture, by considering it as fiber texture, the molding workability of a fin material becomes uniform and the variation in the fin crest height at the time of corrugated shaping can be reduced

further. When the matrix of a raw material is recrystallized structure, the molding workability of a fin material may become uneven, the variation in fin crest height becomes large easily, and it becomes easy to produce the defecting joining between a fin and an aluminium-pipe object at the time of soldering. In order to make the matrix of a raw material into fiber texture, it is preferred to use the technique of adjusting the annealing process temperature at the time of fin material manufacture to a temperature lower than the recrystallizing temperature of an alloy.

[0029]

(Potential difference)

When soldering heating is carried out combining an aluminium-pipe object and blazing fins, such as an extrusion flat perforated pipe which has Zn enveloping layer on the surface, It becomes Takashi gradually as Zn fuses and it is spread in the aluminium-pipe inside of the body, as a result the potential of an aluminium-pipe object serves as **, so that it is close to the surface, and it becomes deep in a depth direction. For this reason, since corrosion advances preferentially in the layer part of a shell, it becomes difficult to produce penetration corrosion and its life of a heat exchanger improves. Rather than the melting point of wax material, since the melting point of Zn is low temperature, Zn forms a fillet in the joined part of a shell and a fin first, subsequently a wax fuses it, and it comes to mix it to Zn. For this reason, the Zn concentration in a fillet turns into high concentration from the Zn concentration of the shell surface or a fin, and the potential of a fillet serves as ** extremely from the potential of the shell surface or a fin.

[0030]

When a heat exchanger is placed by corrosive environment, corrosion, Since it goes on early most in the portion of the most **** potential, a fillet will corrode previously rather than the shell surface or a fin, Since the corrosion of a fillet is promoted so that the potential difference of a fillet and a fin and the potential difference on a fillet and the surface of a shell are large, the phenomenon in which a fin and a shell dissociate will arise.

[0031]

Therefore, in order to prevent secession of the fin from a shell. Although what is necessary is just to bring the potential of a fillet close to the potential of the shell surface or a fin as much as possible, in forming Zn enveloping layer by thermal spraying of low cost, If there is little Zn coating volume, formation of a uniform enveloping layer is difficult, since the above Zn coating volume is needed to some extent, the amount of Zn in a fillet will increase and the potential of a fillet will be **

from the potential of the shell surface or a fin. When potential of a fin is made more into **, there is a problem that the self-corrosion amount of a fin increases and consumption of a fin becomes remarkable.

[0032]

By solving this problem, and adding Cu to the wax material of a fin material, as a result of examining a means to bring the potential of a fillet close to the potential of the shell surface or a fin as much as possible, Also when uniform Zn enveloping layer was formed in the shell surface, without increasing the self-corrosion of a fin material, it found out that potential of a fillet could be made into **. As a result of repeating test examination, it turns out that the potential of a fillet is influenced by Zn coating volume of an aluminium-pipe body surface, and the presentation of a fin material, When the amount of Cu(s) in wax material is made [Zn coating weight of Zn covering aluminium-pipe object] into C % for the amount of Zn in A (g/m^2) and the core material of a fin material B%, -Satisfy the relation of 100 <=-10xA+23xB-106xC<=20, the inner periphery (the time of making the surface of a shell into a peripheral part -- the inner periphery of a shell.) of an aluminium-pipe object that is, when the difference (rest potential of the rest potential-fin of the inner periphery of a shell) of the rest potential of the bottom of the thickness direction of a shell and the rest potential of a fin was not less than 80 mV, it studied that the breakoff phenomenon of a fin was markedly alike and was improved.

[0033]

When the value of (-10xA+23xB-106xC) is smaller than -100, the potential difference of a fillet and a fin becomes large, a fillet corrodes preferentially, and secession of a fin arises at an early stage. When the value of (-10xA+23xB-106xC) exceeds 20, the breakoff phenomenon of a fin does not arise, but a fin corrodes preferentially and heat exchanging performance falls at an early stage extremely. At less than 80 mV, the sacrificial anode effect of a fin is not fully demonstrated for the difference of the rest potential of the inner periphery of an aluminium-pipe object, and the rest potential of a fin, but the corrosion depth of an aluminium-pipe object becomes large easily, penetration corrosion occurs for a short period of time, and the function as a heat exchanger loses.

[0034]

The blazing fin material of this invention the aluminum alloy for core materials and the aluminum alloy for wax material which have the predetermined presentation for constituting a blazing fin material, For example, after carrying out ingot making by semi-continuous casting and homogenizing in accordance with a conventional method,

about wax material. Furthermore it hot-rolls, the clad of the core material after homogenization and the wax material after hot-rolling is carried out, and it cold-rolls after hot-rolling, annealing, cold rolling, or hot-rolling, is manufactured through annealing and finishing cold rolling, and is considered as the plate below 0.10 mm (100 micrometers) in thickness. After slitting this plate to prescribed width, corrugated processing is carried out, and it laminates [the flattened tube flattened tube and by turns] which were constituted from aluminum-Mn system alloys, such as working-fluid passage material (tube material), for example, JIS3003 alloy etc., and is considered as a heat exchanger core by carrying out soldering junction.

[Work example 1]

[0035]

Hereafter, working example of this invention is described as contrasted with a comparative example. These working example shows one embodiment of this invention. and this invention is not limited to this.

Ingot making of the aluminum alloy for core materials and the aluminum alloy for wax material (combination No.A-T) which have the presentation shown in Table 1 by continuous casting is carried out, Homogenize in accordance with a conventional method and it hot-rolls further about the aluminum alloy ingot for wax material, Hot-rolling and after carrying out a clad to both sides of the aluminum alloy ingot for core materials, cold-rolling subsequently and giving intermediate annealing, the clad fin material (H14 temper material) with a thickness of 0.08 mm which has eventually a rate of a wax material clad shown in Table 1 was manufactured through final cold rolling.

[0036]

About the obtained fin material, perform a corrugated fabricating operation and it attaches to the tube material which consists of a porous flattened tube (50 steps) of a pure aluminium system which carried out thermal spraying of the Zn to the surface by a thickness of 10 micrometers, After combining with the header tank and side plate which provided the fitting part beforehand and spraying the flux of a fluoride system, it heated at 600 ** (arrival temperature), and inert atmosphere soldering was performed.

[0037]

[Table 1]

組合せ	芯　材					ろう材		片面クラッド率 %
	Mn	Fe	Si	Zn	その他	Si	Cu	
A	1.6	0.15	0.5	2.5		10	0.2	10
B	2.5	0.15	0.5	2.5		10	0.2	10
C	0.9	0.15	0.5	2.5		10	0.2	10
D	1.2	0.15	0.85	2.5		10	0.2	10
E	1.2	0.15	0.15	2.5		10	0.2	10
F	1.2	0.08	0.5	2.5		10	0.2	10
G	1.2	0.25	0.5	2.5		10	0.2	10
H	1.2	0.15	0.5	3.5		10	0.2	10
I	1.2	0.15	0.5	1.0		10	0.2	10
J	1.2	0.15	0.5	2.5	Zr0.1	10	0.2	10
K	1.2	0.15	0.5	2.5	Cr0.1	10	0.2	10
L	1.2	0.15	0.5	2.5	Ti0.1	10	0.2	10
M	1.2	0.15	0.5	2.5	Zr0.1 Cr0.1	10	0.2	10
N	1.2	0.15	0.5	2.5		7.5	0.2	10
O	1.2	0.15	0.5	2.5		12.5	0.2	10
P	1.2	0.15	0.5	2.5		10	0.08	10
Q	1.2	0.15	0.5	2.5		10	0.35	10
R	1.2	0.15	0.5	2.5		10	0.2	5
S	1.2	0.15	0.5	2.5		10	0.2	17
T	1.2	0.15	0.5	2.5		10	0.2	10

《表注》組成：mass%

[0038]
About the sample board of combination No.A−T of a core material and wax material, the mechanical properties of H14 material, The corrugated processability of a fin, the state of the core after soldering, the fin after soldering junction, The following

methods estimated the fin after the junction fillet of a fin and a tube and the rest potential of a tube surface, and the corrosion test of a core, the fin junction survival rate of a tube and the existence of melting buckling of a joined part, intergranular corrosion-proof nature, and the pitting-proof nature of the tube material joined to the fin material. A result is shown in Table 2 and Table 3.

[0039]

Mechanical properties of H14 material: The JIS No. 5 specimen was produced from H14 material, the tensile test was done, and proof stress, tensile strength, and elongation were measured 0.2%.

Corrugated processability of a fin: The coil of H14 material was ******(ed) to 20-mm width, corrugated shaping was performed using the fin making machine, and that from which abnormalities, such as O, dry rough skin, and a microfissure, produced what has been fabricated normally was judged as **.

The state of the core after soldering: Soldering heating of the attached core was carried out, it judged visually whether the fin would be buckled or not about the formed core, and that from which what buckling has not produced produced O and buckling was taken as x.

The junction fillet of the fin after soldering junction, a fin, and a tube, and the rest potential of a tube surface : The core after soldering heating is cut, Only each test section was exposed, the sample which masked other parts by resin was produced, it was immersed for 24 hours into the 5% NaCl aqueous solution which adjusted pH to three with acetic acid, and the potential to a saturated calomel electrode (S C E) was measured.

[0040]

Calculation of a potential-relation type: $(-10xA+23xB-106xC)$ was calculated from the Zn coating weight A on the surface of a flattened tube (g/mm^2), B% of the Zn concentration in a fin core material, and C% of the amount of Cu(s) in fin wax material.

Existence of melting buckling of a joined part: The representation portion of the joined part was extracted, it embedded to resin, and it was observed whether the joined part would carry out melting buckling.

[0041]

Intergranular-corrosion [-proof] nature: About the core which joins a tube to a fin, after doing a SWAAT corrosion test (ASTM G85-85) for four weeks, the tube of the upper and lower sides of a fin has been held, the tensile test was done, breaking strength was measured, and the mean intensity was made into the index of intergranular corrosion-proof nature judgment of a fin material.

Pitting [-proof] nature of a tube material: The above-mentioned corrosion test measured and estimated the maximum pitting depth produced in the tube.
The junction survival rate of a fin: The fin was mechanically excised after the above-mentioned corrosion test, and the joining rate of the fin was computed by the lower type.
The fin joining rate before the fin joining rate / corrosion test after a fin junction survival-rate (%) = corrosion test
[0042]
[Table 2]

試験材	組合せ	H14 機械的性質		フィン成形性	チューブのZn付着量	コアの座屈	電位関係式の値	自然電位(mVSCE)			
		引張強さ MPa	耐力 MPa		g/mm²			フィレット	フィン	チューブ表面	チューブ内周部
1	A	220	210	○	10	○	-64	-892	-865	-792	-720
2	B	235	220	○	10	○	-64	-892	-850	-792	-720
3	C	185	175	○	10	○	-64	-892	-880	-792	-720
4	D	210	200	○	10	○	-64	-892	-880	-792	-720
5	E	185	175	○	10	○	-64	-892	-860	-792	-720
6	F	195	185	○	10	○	-64	-892	-874	-792	-720
7	G	195	185	○	10	○	-64	-892	-874	-792	-720
8	H	195	185	○	10	○	-41	-895	-895	-792	-720
9	I	195	185	○	10	○	-98	-877	-838	-792	-720
10	J	195	185	○	10	○	-64	-892	-874	-792	-720
11	K	195	185	○	10	○	-64	-892	-874	-792	-720
12	L	195	185	○	10	○	-64	-892	-874	-792	-720
13	M	195	185	○	10	○	-64	-892	-874	-792	-720
14	N	190	180	○	10	○	-64	-905	-880	-792	-720
15	O	200	190	○	10	○	-64	-885	-870	-792	-720
16	P	195	185	○	10	○	-51	-915	-905	-792	-720
17	Q	210	200	○	10	○	-80	-870	-845	-792	-720
18	R	195	185	○	10	○	-64	-892	-874	-792	-720
19	S	205	195	○	10	○	-64	-892	-874	-792	-720
20	H	195	185	○	15	○	-91	-978	-895	-823	-720
21	T	195	185	○	7	○	-34	-880	-874	-785	-720
22	T	195	185	○	3	○	6	-850	-875	-775	-720
23	Q	210	200	○	4	○	-20	-840	-845	-780	-720

[0043]
[Table 3]

試験材	組合せ	電位差		フィン接合残存率 %	チューブ最大腐食深さ mm	SWAAT 試験後の平均破断強度 MPa
		（フィン）－（フィレット）	（チューブ内周部）－（フィン）			
1	A	27	145	90	0.06	49
2	B	42	130	85	0.07	54
3	C	12	160	95	0.04	46
4	D	12	160	90	0.06	47
5	E	32	140	80	0.04	45
6	F	18	154	90	0.04	46
7	G	18	154	90	0.06	48
8	H	0	175	100	0.04	42
9	I	39	118	80	0.08	51
10	J	18	154	90	0.05	47
11	K	18	154	90	0.05	46
12	L	18	154	90	0.05	48
13	M	18	154	90	0.05	46
14	N	25	160	80	0.06	44
15	O	15	150	95	0.07	45
16	P	10	185	70	0.04	53
17	Q	25	125	100	0.09	42
18	R	18	154	70	0.06	46
19	S	18	154	90	0.05	45
20	H	83	175	70	0.07	41
21	T	6	154	90	0.06	53
22	T	-25	155	100	0.05	56
23	Q	-5	125	100	0.05	48

[0044]
Each of sample board No.1 according to this invention – 23 was excellent in fin shaping, and did not have buckling of the core after soldering, either, the junction survival rate of the fin after a corrosion test is also as good as not less than 70%, and, as for the maximum pitting depth of a tube, the outstanding pitting-proof nature below 0.1 mm was shown so that it might see in Table 2. The average breaking strength after a SWAAT examination is also 40 or more MPa, and good intergranular corrosion-proof nature was shown.
[Comparative example 1]
[0045]
Ingot making of the aluminum alloy for core materials and the aluminum alloy for wax material (combination No.a–q) which have the presentation shown in Table 4 by continuous casting is carried out, Homogenize in accordance with a conventional method and it hot-rolls further about the aluminum alloy ingot for wax material, Hot-rolling and after carrying out a clad to both sides of the aluminum alloy ingot for core materials, cold-rolling subsequently and giving intermediate annealing, the clad fin material (H14 temper material) with a thickness of 0.08 mm which has eventually a rate of a wax material clad shown in Table 4 was manufactured through final cold rolling.
[0046]
About the obtained fin material, a corrugated fabricating operation is performed like working example 1, It attaches to the tube material which consists of a porous flattened tube (50 steps) of a pure aluminium system which performed Zn processing to the surface, After combining with the header tank and side plate which provided the fitting part beforehand and spraying the flux of a fluoride system, it heated at 600 ** (arrival temperature), and inert atmosphere soldering was performed.
[0047]
[Table 4]

組合せ	芯材					ろう材		片面クラッド率 %
	Mn	Fe	Si	Zn	その他	Si	Cu	
a	0. 5	0. 15	0. 5	2. 5		10	0. 2	10
b	2. 9	0. 15	0. 5	2. 5		10	0. 2	10
c	1. 2	0. 15	0. 05	2. 5		10	0. 2	10
d	1. 2	0. 15	1. 3	2. 5		10	0. 2	10
e	1. 2	0	0. 5	2. 5		10	0. 2	10
f	1. 2	0. 35	0. 5	2. 5		10	0. 2	10
g	1. 2	0. 15	0. 5	0. 6		10	0. 2	10
h	1. 2	0. 15	0. 5	4. 4		10	0. 2	10
i	1. 2	0. 15	0. 5	2. 5	Zr0. 4	10	0. 2	10
j	1. 2	0. 15	0. 5	2. 5	Cr0. 4	10	0. 2	10
k	1. 2	0. 15	0. 5	2. 5	Ti0. 4	10	0. 2	10
l	1. 2	0. 15	0. 5	2. 5		4	0. 2	10
m	1. 2	0. 15	0. 5	2. 5		15	0. 2	10
n	1. 2	0. 15	0. 5	2. 5		10	0. 02	10
o	1. 2	0. 15	0. 5	2. 5		10	0. 6	10
p	1. 2	0. 15	0. 5	2. 5		10	0. 2	2
q	1. 2	0. 15	0. 5	2. 5		10	0. 2	30

《表注》組成：mass%

[0048]

About the sample board of combination No.a-q of a core material and wax material, by the same method as working example 1. The mechanical properties of H14 material, the corrugated processability of a fin, the state of the core after soldering, The fin after the junction fillet of the fin after soldering junction, a fin, and a tube and the rest potential of a tube surface, and the corrosion test of a core, the fin junction survival rate of a tube and the existence of melting buckling of a joined part, intergranular corrosion-proof nature, and the pitting-proof nature of the tube material joined to the

fin material were evaluated. A result is shown in Table 5 and Table 6.
[0049]
[Table 5]

試験材	組合せ	H14 機械的性質		フィン成形性	チューブのZn付着量	コアの座屈	電位関係式の値	自然電位(mVSCE)			
		引張強さ MPa	耐力 MPa		g/mm²			フィレット	フィン	チューブ表面	チューブ内周部
24	a	110	90	△	10	×	-64	-892	-900	-792	-720
25	b	--	--	--	--	--	--	--	--	--	--
26	c	130	110	△	10	×	-64	--	--	--	--
27	d	190	180	○	10	×	-64	--	--	--	--
28	e	195	185	○	10	○	-64	-892	-874	-792	-720
29	f	200	190	○	10	×	-64	--	--	--	--
30	g	195	185	○	10	○	-107	-883	-807	-792	-720
31	h	195	185	○	5	○	30	-900	-930	-792	-720
32	i	--	--	--	--	--	--	--	--	--	--
33	j	--	--	--	--	--	--	--	--	--	--
34	k	--	--	--	--	--	--	--	--	--	--
35	l	175	165	○	10	○	-64	--	--	--	--
36	m	--	--	--	--	--	--	--	--	--	--
37	n	195	185	○	10	○	-45	-922	-926	-792	-720
38	o	225	210	○	10	○	-106	-830	-770	-792	-720
39	p	190	180	○	10	○	-64	--	--	--	--
40	q	200	190	○	10	×	-64	--	--	--	--

[0050]
[Table 6]

試験材	組合せ	電位差		フィン接合残存率	チューブ最大腐食深さ	SWAAT 試験後の平均破断強度
		（フィン）－（フィレット）	（チューブ内周部）－（フィン）	%	mm	MPa
24	a	-8	180	--	--	42
25	b	--	--	--	--	--
26	c	--	--	--	--	--
27	d	--	--	--	--	--
28	e	18	154	90	0.09	48
29	f	--	--	--	--	--
30	g	76	87	30	0.15	55
31	h	-30	210	100	0.04	15
32	i	--	--	--	--	--
33	j	--	--	--	--	--
34	k	--	--	--	--	--
35	l	--	--	--	--	--
36	m	--	--	--	--	--
37	n	-4	206	20	0.08	52
38	o	60	50	100	0.18	10
39	p	--	--	--	--	--
40	q	--	--	--	--	--

[0051]
As shown in Tables 5 and 6, since sample board No.24 has few amounts of Mn of a core material, the tensile strength of a fin is low and a fin moldability is inferior in it. Since sample board No.25 had many amounts of Mn of a core material, the big and rough compound at the time of casting arose, strip-processing nature was injured, and manufacture of the healthy fin material of it was not completed. Since sample board No.26 has few amounts of Si of a core material, the tensile strength of a fin material is

low and a fin moldability is inferior in it. Since sample board No.27 had many amounts of Si of a core material, buckling resulting from local melting produced it in the soldering joined part. Since sample board No.28 had few Fe amounts of a core material, its intensity of the fin was low and buckling produced it at the time of soldering. Since sample board No.29 had many Fe amounts of a core material, the crystal grain diameter of the core material after soldering became small, the melting wax permeated the grain boundary of the core material, and buckling produced it on the fin.

[0052]

Since [as for which the amount of Zn of a core material becomes empty] there was nothing, sample board No.30 did not have an enough sacrificial anode effect, and deep pitting produced it in the tube material. Sample board No.31 had many amounts of Zn of a core material, and in order that the value of a potential relation type might cross an appropriate range, the corrosion of the fin itself became large. Since sample board No.32, No.33, and No.34 had much the amount of Zr, the amount of Cr(s), and Ti quantity of a core material respectively, the compound big and rough at the time of casting generated, strip-processing nature was injured, and manufacture of the healthy fin material of them was not completed.

[0053]

Since sample board No.35 had few amounts of Si of wax material, it became insufficient [the quantity of the flowing wax], and was inferior in junction nature, and the corrosion test of it was not completed. Since sample board No.36 had many amounts of Si of wax material, cutting of material produced it with strip processing. Since sample board No.37 had few amounts of Cu(s) of wax material, the fillet corroded preferentially and the fin junction survival rate fell. Since sample board No.38 had many amounts of Cu(s) of wax material, intergranular corrosion arose on the fin and the fin became tattering after the corrosion test. Since sample board No.39 had the low rate of a clad of wax material, it became insufficient [the quantity of the flowing wax], and was inferior in junction nature, and the corrosion test of it was not completed. Since the rate of a clad of wax material is high, as a result of there being many amounts of melting of a wax and a core material's corroding, buckling produced sample board No.40 in the joined part.

[Industrial applicability]

[0054]

The aluminum alloy blazing fin material for heat exchangers of this invention is used, Since the problem of secession of a fin is not produced even if a heat exchanger is placed under corrosive environment and the sacrificial anode effect of a fin and the

anticorrosive effect of a tube surface are also fully demonstrated when a heat exchanger is assembled by soldering, reinforcement of a heat exchanger is attained.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention]

[0001]

this invention -- the aluminum alloy blazing fin material for heat exchangers -- in detail, Like a radiator, a heater core, an oil cooler, an intercooler, the capacitor of a car air-conditioner, and an evaporator, soldering junction of the aluminium-pipe object (an aluminum alloy shell is included) which constitutes a fin and a working-fluid passage is carried out.

Therefore, it is related with the aluminum alloy blazing fin material for aluminum alloy made heat exchangers formed, especially the aluminum alloy blazing fin material excellent in the corrosion resistance of a fillet.

[Translation done.]

PRIOR ART

[Background of the Invention]
[0002]
The aluminum alloy made heat exchanger is widely used as heat exchangers for cars, such as an evaporator of a radiator, a heater core, an oil cooler, an intercooler, and a car air-conditioner, and a capacitor. These aluminum alloy made heat exchangers A pure aluminium system, an aluminum-Cu system alloy, On the surface of aluminium-pipe objects (working-fluid passage material), such as an extrusion flattened tube which consists of an aluminum-Mn system alloy, an aluminum-Mn-Cu system alloy, etc. The fin which fabricated the brazing sheet which carried out the clad of the aluminum-Si system alloy wax material to the core material of the aluminum-Mn system alloy of JIS A3003 and JISA3203 grade wavelike, It is assembled by attaching by flux soldering which uses chloride system flux, inert gas atmosphere soldering using fluoride system flux, or vacuum soldering.
[0003]
Pitting peculiar to an aluminum material arises on an aluminium-pipe object, and the aluminum alloy made heat exchanger for cars has the problem that pitting reaches to the inside of a shell and a heat exchange function loses, when used in a cruel environment. In order to solve this problem, the material which formed Zn (Zn alloy is included) enveloping layer **** to the Electrochemistry Sub-Division target in the surface of an aluminium-pipe object from the aluminium-pipe object, and made potential on the surface of a shell ** from the aluminium-pipe inside-of-the-body part is used, and the technique of carrying out soldering junction of the fin is adopted on it.
[0004]
Usually, although Zn enveloping layer is formed in the surface of aluminium-pipe objects, such as an aluminum flattened tube by which extrusion molding was carried out, by carrying out thermal spraying of Zn or the Zn alloy (refer to patent documents 1), When soldering junction of the fin material which becomes the aluminium-pipe object which carried out flame spraying of the Zn from blazing was carried out and the heat exchanger for cars is produced, The fillet part of an aluminium-pipe object and a fin corrodes, and although the corrosion of a fin is slight, the problem that an aluminium-pipe object and a fin dissociate and the heat transfer performance of a heat exchanger falls may arise.
[0005]

the dust by which it was generated with the spike tire of the car on the other hand in recent years -- health top damage -- ****** -- the studless tire being used instead of the spike tire, in order to be anxious about things, but. Since a studless tire is inferior to the braking performance in a freezing road surface, at the time of the snow cover of winter, and road surface freezing, sprinkling snow melting agents, such as a calcium chloride and sodium chloride, in large quantities on a road surface at a road surface for slip accident prevention of a car is performed. In order for these snow melting agents to adhere to the heat exchanger of the car under run and to promote the corrosion of a heat exchanger, it dissociates at an early stage, and an aluminium-pipe object and a fin also produce the problem that a fin falls out, in being cruel.

[0006]

Although a heat exchanger is painted after soldering, in order that it might improve the adhesion of a coat and might raise corrosion resistance, chromic acid chromate and phosphoric acid chromate treatment were performed to the surface of the aluminum member which constitutes a heat exchanger, but. In order to abolish chromate treatment from an environmental problem, advance of the corrosion of a fillet is easy to separate a fin early from an aluminium-pipe object increasingly.

[Patent documents 1] JP,H2-138455,A

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention]

[0013]

According to this invention, profit which is excellent in a moldability and makes it possible to prevent the priority corrosion of a fillet is provided with 100 micrometers of the following (0.10 mm) aluminum alloy blazing fin materials for heat exchangers for thickness. By using the aluminum alloy blazing fin material concerned, Since the problem which a fin separates from an aluminium-pipe object is solved and the sacrificial anode effect of a fin and the anticorrosive effect of an aluminium-pipe body surface are also fully demonstrated even if a heat exchanger is placed under corrosive environment, reinforcement of a heat exchanger can be attained.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]

[0007]

In order that artificers may solve this problem, as a result of examining many things, when carrying out soldering junction of the fin material at the aluminium-pipe object which carried out flame spraying of the Zn, Zn is spread in the fillet part of an aluminium-pipe object and a fin, It turned out that a fillet part becomes the Electrochemistry Sub-Division target with ** from an aluminium-pipe object and a fin, therefore a fillet part carries out priority corrosion. If especially diffusion of Zn to a fillet part lessens quantity of becoming remarkable and Zn by which flame spraying is carried out when there is much Zn coating weight of an enveloping layer as a result of adding test examination furthermore, a certain amount of corrosion-resistant improvement will be obtained, but. It found out the presentation of the Zn layer covered by that the not necessarily outstanding corrosion resistance cannot be acquired only by lessening coating weight of Zn, an aluminium-pipe object, a fin material, and the aluminium-pipe object, and that these combination influenced the corrosion resistance of a heat exchanger.

[0008]

this invention is made based on the above-mentioned knowledge, and comes out. It is an aluminum alloy blazing fin material for the heat exchangers for cars which the purpose uses the aluminium-pipe object in which Zn enveloping layer was formed, and does not perform chromate treatment. While excelling in a moldability and controlling pitting generating of an aluminium-pipe object under cruel corrosive environment, it excels in the corrosion resistance of a soldering part, and is in providing the aluminum alloy blazing fin material for heat exchangers which can prevent a fin from seceding from an aluminium-pipe object.

[Translation done.]

MEANS

[Means for Solving the Problem]
[0009]
An aluminum alloy blazing fin material for heat exchangers by Claim 1 of this invention for attaining the above-mentioned purpose, It is an aluminum alloy blazing fin material attached to Zn covering aluminium-pipe object which carries out the clad of the aluminum-Si system alloy wax material to both sides of a core material, and constitutes a working-fluid passage by soldering, Said core material Mn:0.8-2.5%, Si:0.1-1.0%, Fe:0.06-0.3%, Zn : With an aluminum alloy which consists of remainder aluminum and an impurity, contain 0.8 to 4.0%, and it is constituted, and said wax material, Si: 6-13%, Cu: 0.06 to 0.4% is contained, it comprises an aluminum alloy which consists of remainder aluminum and an impurity, and the clad of the wax material is carried out to both sides of a core material by 3 to 20% of thickness of whole thickness, respectively.
[0010]
In Claim 1, as for an aluminum alloy blazing fin material for heat exchangers by Claim 2, said core material contains 1 of Zr:0.05-0.3%, Cr:0.05-0.3%, and Ti:0.05-0.3% of sorts, and two sorts or more further.
[0011]
An aluminum alloy blazing fin material for heat exchangers by Claim 3 is characterized by tensile strength being [a difference of 180 - 250MPa, tensile strength, and proof stress] 20 or less MPa in Claim 1 or 2.
[0012]
An aluminum alloy blazing fin material for heat exchangers by Claim 4, When the amount of Cu(s) in wax material is made [Zn coating weight of said Zn covering aluminium-pipe object] into C % for the amount of Zn in A (g/m^2) and a core material of said fin material B% in either of the Claims 1-3, -A relation of $100 <= -10xA+23xB-106xC <= 20$ is satisfied, and it is characterized by a difference of rest potential of an inner periphery of said aluminium-pipe object and rest potential of a fin being not less than 80 mV.

[Translat on done.]

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(54)【発明の名称】熱交換器用アルミニウム合金ブレージングフィン材

(57)【要約】
【目的】　Ｚｎ被覆層を形成したアルミニウム管体を使用し、クロメート処理行わない自動車用熱交換器用のアルミニウム合金ブレージングフィン材であって、成形性に優れ、苛酷な腐食環境下においてアルミニウム管体の孔食発生を抑制するとともに、ろう付け部の耐食性に優れ、フィンがアルミニウム管体から離脱するのを防止できる熱交換器用アルミニウム合金ブレージングフィン材を提供する。
【構成】　芯材の両面にＡｌ－Ｓｉ系合金ろう材をクラッドしてなり、前記芯材は、Ｍｎ：０．８～２．５％、Ｓｉ：０．１～１．０％、Ｆｅ：０．０６～０．３％、Ｚｎ：０．８～４．０％を含有し、残部Ａｌおよび不純物からなるアルミニウム合金で構成され、前記ろう材は、Ｓｉ：６～１３％、Ｃｕ：０．０６～０．４％を含有し、残部Ａｌおよび不純物からなるアルミニウム合金で構成され、ろう材が芯材の両面にそれぞれ全体厚さの３～２０％の厚さでクラッドされていることを特徴とする。
【選択図】　なし

【特許請求の範囲】
【請求項1】
芯材の両面にＡｌ－Ｓｉ系合金ろう材をクラッドしてなり、作動流体通路を構成するＺｎ被覆アルミニウム管体にろう付けにより組付けられるアルミニウム合金ブレージングフィン材であって、前記芯材は、Ｍｎ：０．８～２．５％（質量％、以下同じ）、Ｓｉ：０．１～１．０％、Ｆｅ：０．０６～０．３％、Ｚｎ：０．８～４．０％を含有し、残部Ａｌおよび不純物からなるアルミニウム合金で構成され、前記ろう材は、Ｓｉ：６～１３％、Ｃｕ：０．０６～０．４％を含有し、残部Ａｌおよび不純物からなるアルミニウム合金で構成され、ろう材が芯材の両面にそれぞれ全体厚さの３～２０％の厚さでクラッドされていることを特徴とする熱交換器用アルミニウム合金ブレージングフィン材。
【請求項2】
前記芯材が、さらにＺｒ：０．０５～０．３％、Ｃｒ：０．０５～０．３％、Ｔｉ：０．０５～０．３％のうちの１種または２種以上を含有することを特徴とする請求項１記載の熱交換器用アルミニウム合金ブレージングフィン材。
【請求項3】
引張強さが１８０～２５０ＭＰａ、引張強さと耐力の差が２０ＭＰａ以下であることを特徴とする請求項１または２記載の熱交換器用アルミニウム合金ブレージングフィン材。
【請求項4】
前記Ｚｎ被覆アルミニウム管体のＺｎ付着量をＡ（ｇ／m^2）、前記フィン材の芯材中のＺｎ量をＢ％、ろう材中のＣｕ量をＣ％としたとき、$-100 \leq -10 \times A + 23 \times B - 106 \times C \leq 20$の関係を満足し、前記アルミニウム管体の内周部の自然電位とフィンの自然電位との差が８０ｍＶ以上であることを特徴とする請求項１～３のいずれかに記載の熱交換器用アルミニウム合金ブレージングフィン材。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、熱交換器用アルミニウム合金ブレージングフィン材、詳しくは、ラジエータ、ヒータコア、オイルクーラ、インタークーラ、カーエアコンのコンデンサ、エバポレータ等のように、フィンと作動流体通路を構成するアルミニウム管体（アルミニウム合金管体を含む）をろう付け接合することにより形成されるアルミニウム合金製熱交換器用アルミニウム合金ブレージングフィン材、特にフィレットの耐食性に優れたアルミニウム合金ブレージングフィン材に関する。
【背景技術】
【0002】
アルミニウム合金製熱交換器は、ラジエータ、ヒータコア、オイルクーラ、インタークーラ、カーエアコンのエバポレータやコンデンサ等の自動車用熱交換器として広く使用されている。これらのアルミニウム合金製熱交換器は、純アルミニウム系、Ａｌ－Ｃｕ系合金、Ａｌ－Ｍｎ系合金、Ａｌ－Ｍｎ－Ｃｕ系合金等からなる押出偏平管等のアルミニウム管体（作動流体通路材）の表面に、ＪＩＳ　Ａ３００３、ＪＩＳＡ３２０３等のＡｌ－Ｍｎ系合金の芯材にＡｌ－Ｓｉ系合金ろう材をクラッドしたブレージングシートを波状に成形したフィンを、塩化物系フラックスを使用するフラックスろう付け、フッ化物系フラックスを用いる不活性ガス雰囲気ろう付け、あるいは真空ろう付けにより組付けることにより組み立てられている。
【0003】
自動車用アルミニウム合金製熱交換器は、苛酷な環境で使用された場合、アルミニウム管体にアルミニウム材に特有の孔食が生じ、孔食が管体の内部まで達して熱交換機能が損失するという問題がある。この問題を解決するために、アルミニウム管体の表面にアルミニウム管体より電気化学的に卑なＺｎ（Ｚｎ合金を含む）被覆層を形成してアルミニウム管体内部より管体表面の電位を卑にした材料が使用され、その上にフィンをろう付け接合する手法が採用されている。

【0004】
通常、Ｚｎ被覆層は、押出成形されたアルミニウム偏平管等のアルミニウム管体の表面にＺｎまたはＺｎ合金を溶射することにより形成されるが（特許文献１参照）、Ｚｎを溶射被覆したアルミニウム管体にブレージングからなるフィン材をろう付け接合して自動車用熱交換器を作製した場合、アルミニウム管体とフィンとのフィレット部が腐食し、フィンの腐食が軽度であるにもかかわらず、アルミニウム管体とフィンとが分離して熱交換器の伝熱性能が低下するという問題が生じることがある。
【0005】
一方、近年、自動車のスパイクタイヤにより発生した粉塵により、健康上害をおよぼすことが懸念されるため、スパイクタイヤに代わってスタッドレスタイヤが使用されているが、スタッドレスタイヤは凍結路面における制動性能に劣るため、冬季の積雪時および路面凍結時において、自動車のスリップ事故防止のために、路面に塩化カルシウムや塩化ナトリウムなどの融雪剤を大量に路面に散布することが行われている。これらの融雪剤は走行中の自動車の熱交換器に付着して熱交換器の腐食を促進させるため、アルミニウム管体とフィンとが早期に分離して、苛酷な場合にはフィンが脱落するという問題も生じる。
【0006】
また、熱交換器は、ろう付け後に塗装されるが、塗膜の密着性を高め耐食性を向上させるために、熱交換器を構成するアルミニウム部材の表面にクロム酸クロメートやリン酸クロメート処理が施されていたが、環境問題からクロメート処理が廃止されるようになってきたため、フィレットの腐食の進行が早くなり、フィンがアルミニウム管体からますます分離し易くなっている。
【特許文献1】特開平２－１３８４５５号公報
【発明の開示】
【発明が解決しようとする課題】
【0007】
発明者らは、この問題を解決するために、種々検討を行った結果、Ｚｎを溶射被覆したアルミニウム管体にフィン材をろう付け接合する際、アルミニウム管体とフィンとのフィレット部にＺｎが拡散して、フィレット部がアルミニウム管体およびフィンより電気化学的に卑となり、そのためフィレット部が優先腐食することがわかった。さらに試験検討を加えた結果、フィレット部へのＺｎの拡散は、とくに被覆層のＺｎ付着量が多い場合に顕著となること、溶射被覆されるＺｎの量を少なくすると、ある程度の耐食性の改善は得られるが、Ｚｎの付着量を少なくしただけでは必ずしも優れた耐食性を得ることができないこと、アルミニウム管体、フィン材およびアルミニウム管体に被覆されるＺｎ層の組成と、これらの組合わせが熱交換器の耐食性に影響することを見出した。
【0008】
本発明は、上記の知見に基づいてなされたものであり、その目的は、とくに、Ｚｎ被覆層を形成したアルミニウム管体を使用し、クロメート処理を行わない自動車用熱交換器用のアルミニウム合金ブレージングフィン材であって、成形性に優れ、苛酷な腐食環境下においてアルミニウム管体の孔食発生を抑制するとともに、ろう付け部の耐食性に優れ、フィンがアルミニウム管体から離脱するのを防止できる熱交換器用アルミニウム合金ブレージングフィン材を提供することにある。
【課題を解決するための手段】
【0009】
上記の目的を達成するための本発明の請求項１による熱交換器用アルミニウム合金ブレージングフィン材は、芯材の両面にＡｌ－Ｓｉ系合金ろう材をクラッドしてなり、作動流体通路を構成するＺｎ被覆アルミニウム管体にろう付けにより組付けられるアルミニウム合金ブレージングフィン材であって、前記芯材は、Ｍｎ：０．８～２．５％、Ｓｉ：０．１～１．０％、Ｆｅ：０．０６～０．３％、Ｚｎ：０．８～４．０％を含有し、残部Ａｌおよび不純物からなるアルミニウム合金で構成され、前記ろう材は、Ｓｉ：６～１３％、Ｃｕ：０．０６～０．４％を含有し、残部Ａｌおよび不純物からなるアルミニウム合金で

構成され、ろう材が芯材の両面にそれぞれ全体厚さの３～２０％の厚さでクラッドされていることを特徴とする。
【0010】
請求項２による熱交換器用アルミニウム合金ブレージングフィン材は、請求項１において、前記芯材が、さらにＺｒ：０．０５～０．３％、Ｃｒ：０．０５～０．３％、Ｔｉ：０．０５～０．３％のうちの１種または２種以上を含有することを特徴とする。
【0011】
請求項３による熱交換器用アルミニウム合金ブレージングフィン材は、請求項１または２において、引張強さが１８０～２５０ＭＰａ、引張強さと耐力の差が２０ＭＰａ以下であることを特徴とする。
【0012】
請求項４による熱交換器用アルミニウム合金ブレージングフィン材は、請求項１～３のいずれかにおいて、前記Ｚｎ被覆アルミニウム管体のＺｎ付着量をＡ（ｇ／m^2 ）、前記フィン材の芯材中のＺｎ量をＢ％、ろう材中のＣｕ量をＣ％としたとき、－１００≦－１０×Ａ＋２３×Ｂ－１０６×Ｃ≦２０の関係を満足し、前記アルミニウム管体の内周部の自然電位とフィンの自然電位との差が８０ｍＶ以上であることを特徴とする。
【発明の効果】
【0013】
本発明によれば、成形性に優れ、フィレットの優先腐食を防止することを可能とする、とくに厚さが１００μｍ（０．１０ｍｍ）以下の熱交換器用アルミニウム合金ブレージングフィン材が提供される。当該アルミニウム合金ブレージングフィン材を使用することにより、熱交換器が腐食環境下に置かれても、フィンがアルミニウム管体から分離する問題が解消され、またフィンの犠牲陽極効果やアルミニウム管体表面の防食効果も十分に発揮されるため、熱交換器の長寿命化が達成できる。
【発明を実施するための最良の形態】
【0014】
本発明の熱交換器用アルミニウム合金ブレージングフィン材における（１）合金成分、（２）ろう材のクラッド率、（３）機械的性質、（４）電位差について説明する。
【0015】
（１）合金成分
以下、本発明における合金成分の意義およびその限定理由について説明する。
（芯材）
芯材中のＭｎは、芯材の強度を向上させ、耐高温座屈性を改善するよう機能する。Ｍｎの好ましい含有範囲は、０．８～２．５％であり、０．８％未満ではその効果が小さく、２．５％を越えて含有すると、鋳造時に粗大な晶出物が生成して圧延加工性が害され、板材の製造が困難となる。Ｍｎのさらに好ましい含有量は１．０～１．７％である。
【0016】
芯材中のＦｅは、Ｍｎと共存して、ろう付け前及びろう付け後のフィン材の強度を向上させる。Ｆｅの好ましい含有量は０．０６～０．３％の範囲であり、０．０６％未満ではその効果が小さく、０．３％を越えると、結晶粒が細かくなって、溶融ろうが芯材中に浸食し易くなり、耐高温座屈性が低下し、自己腐食性が増大する。Ｆｅのさらに好ましい含有量は０．０６～０．２５％の範囲である。
【0017】
芯材中のＳｉは、Ｍｎと結合して微細なＡｌ－Ｍｎ－Ｓｉ系化合物を生成し、フィン材の強度を向上させるとともに、Ｍｎの固溶量を減少させて熱伝導度（電気伝導度）を向上させる。また、ろう材のＳｉが芯材に拡散することを抑制するため十分なフィレットを形成することができる。Ｓｉの好ましい含有範囲は０．１～１．０％であり、０．１％未満ではその効果が十分ではなく、１．０％を越えると、粒界に多く存在して、粒界近傍にＳｉ濃度の低い領域を形成させるため粒界腐食が生じ易くなる。Ｓｉのさらに好ましい含有量は０．３～０．７％の範囲である。

【0018】
芯材中のＺｎは、芯材の電位を卑にして犠牲陽極効果を高める。Ｚｎの好ましい含有範囲は０．８〜４．０％であり、０．８％未満ではその効果が小さく、４．０％を越えて含有すると、芯材自体の自己耐食性が悪くなり、粒界腐食感受性も増加する。Ｚｎのさらに好ましい含有量は１．５〜３．０％の範囲である。
【0019】
芯材中のＺｒ、Ｃｒ及びＴｉは、ろう付け前及びろう付け後のフィン材の強度を向上させるとともに、高温座屈性を改良する。Ｚｒ、ＣｒおよびＴｉの好ましい含有範囲は、共に０．０５〜０．３％であり、０．０５％未満ではその効果が小さく、０．３％を越えて含有すると、鋳造時に粗大な晶出物が生成して圧延加工性を害し、板材の製造が困難となる。
【0020】
芯材中には、それぞれ０．３％以下のＩｎ、Ｓｎ、Ｇａが添加されてもよく、これらの元素はいずれもフィン材の熱伝導度をほとんど低下させることなく電位を卑にし、犠牲陽極効果を与える。また、０．１％以下のＰｂ、Ｌｉ、Ｓｒ、Ｃａ、Ｎａが含有されていても本発明の効果が害されることはない。強度向上のために、それぞれ０．３％以下のＶ、Ｍｏ、Ｎｉ、酸化防止のために、０．１％以下のＢｅを添加することもできる。
【0021】
（ろう材）
ろう材中のＳｉは、ろう材の融点を下げ、溶融ろうの流動性を高めるよう機能する。Ｓｉの好ましい含有範囲は６〜１３％であり、６％未満ではその効果が小さく、１３％を越えると融点が急激に高くなり、製造時の加工性も低下する。Ｓｉのさらに好ましい含有量は７〜１２％の範囲である。
【0022】
ろう材中のＣｕは、ろう付け後のフィレットの電位を貴にするよう機能する。Ｃｕの好ましい含有範囲は０．０６〜０．４％であり、０．０６％未満ではその効果が小さく、０．４％を越えると、フィン自体の電位も貴となり、そのため犠牲陽極効果が低下する。また、自己耐食性が低下して粒界腐食が生じ易くなる。Ｃｕのさらに好ましい含有量は０．１〜０．３％である。
【0023】
ろう材中には、それぞれ０．３％以下のＣｒ、Ｍｎ、それぞれ０．１％以下のＰｂ、Ｌｉ、Ｃａが含まれていても、本発明の効果が損なわれることはない。鋳造組織の微細化のために、０．３％以下のＴｉ、０．０１％以下のＢ、ろう材中のＳｉ粒子の微細化のために、それぞれ０．１％以下のＳｒ、Ｎａ、電位を低くして犠牲陽極効果を与えるために、それぞれ０．１％以下のＩｎ、Ｓｎ、Ｇａ、表面酸化皮膜の成長を抑制するために、０．１％以下のＢｅ、ろう材の流動性を向上させるために、０．４％以下のＢｉを添加することもできる。
【0024】
ろう材中のＦｅは、多量に含まれると自己腐食が生じ易くなるため、０．８％以下に制限することが望ましい。また、ろう材中のＭｇは、フッ化物系のフラックスを使用する不活性雰囲気ろう付けを適用する場合には、フッ化物系のフラックスと反応してろう付け性を阻害するため、０．５％以下に制限するのが好ましい。
【0025】
（ろう材のクラッド率）
フィン材におけるろう材のクラッド率は、厚さ１００μｍ（０．１０ｍｍ）以下のフィン材においては、片面で平均３〜２０％とするのが好ましい。片面のクラッド率が３％未満では、芯材にクラッドされるろう材の厚さが小さ過ぎて均一なクラッド率が得難く、ろう材をクラッドされたフィン材の製造が困難となる。２０％を越えると、ろうの溶融量が多くなり過ぎ、芯材が溶解、浸食され易くなるとともに、板厚が薄くなるため強度が低下する。さらに好ましいクラッド率は５〜１５％である。

【0026】
（機械的性質）
本発明の熱交換器用アルミニウム合金ブレージングフィン材は、成形前のフィン材（素材）の引張強さが１８０～２５０ＭＰａの範囲内にあり、（引張強さ－耐力）の値が２０ＭＰａ以下であることが重要である。成形前のフィン材の引張強さおよび（引張強さ－耐力）の値を上記の範囲とすることにより、成形性に優れ、コルゲート成形時のフィン山高さのバラツキをなくすことができる。
【0027】
素材の引張強さが１８０ＭＰａ未満では、コルゲート成形時の加工応力によって異常変形し易く、フィン山高さのバラツキが大きくなり、素材の引張強さが２５０ＭＰａを越えると、コルゲート成形時のスプリングバックが大きくなって、フィン山高さのバラツキが大きくなり、いずれの場合も、ろう付け時にフィンとアルミニウム管体との間に接合不良が生じ易くなる。なお、素材の引張強さを１８０～２５０ＭＰａの範囲内とし、（引張強さ－耐力）の値が２０ＭＰａ以下とするには、フィン材製造時の均質化処理温度、焼鈍処理温度、冷間圧延の加工度を調整する等の手法を用いることができる。
【0028】
また、本発明の熱交換器用アルミニウム合金ブレージングフィン材においては、素材のマトリックスを繊維組織とするのが好ましく、繊維組織とすることによりフィン材の成形加工性が均一となり、コルゲート成形時のフィン山高さのバラツキをさらに低減することができる。素材のマトリックスが再結晶組織の場合には、フィン材の成形加工性が不均一となることがあり、フィン山高さのバラツキが大きくなり易く、ろう付け時にフィンとアルミニウム管体との間の接合不良が生じ易くなる。素材のマトリックスを繊維組織とするには、フィン材製造時の焼鈍処理温度を合金の再結晶温度より低い温度に調整する手法を用いるのが好ましい。
【0029】
（電位差）
表面にＺｎ被覆層を有する押出偏平多孔管等のアルミニウム管体とブレージングフィンを組合わせてろう付け加熱した場合、Ｚｎが溶融してアルミニウム管体中に拡散し、その結果、アルミニウム管体の電位は表面に近いほど卑となり、深さ方向に深くなるにつれて徐々に貴となる。このため、腐食は管体の表層部において優先的に進行するので、貫通腐食が生じ難くなり、熱交換器の寿命が向上する。Ｚｎの融点はろう材の融点よりも低温であるから、まず管体とフィンとの接合部にＺｎがフィレットを形成し、ついでろうが溶融してＺｎに混合するようになる。このため、フィレット中のＺｎ濃度は、管体表面やフィンのＺｎ濃度より高濃度となり、フィレットの電位は管体表面やフィンの電位よりきわめて卑となる。
【0030】
熱交換器が腐食環境に置かれた場合、腐食は、最も卑な電位の部分において最も早く進行するから、管体表面やフィンよりもフィレットが先に腐食することとなり、フィレットとフィンの電位差およびフィレットと管体表面の電位差が大きいほどフィレットの腐食が促進されるため、フィンと管体が分離するという現象が生じることとなる。
【0031】
従って、管体からのフィンの離脱を防止するためには、フィレットの電位を管体表面やフィンの電位に出来るだけ近づければよいが、低コストの溶射によりＺｎ被覆層を形成する場合には、Ｚｎ被覆量が少ないと均一な被覆層の形成が困難で、ある程度以上のＺｎ被覆量が必要となるため、フィレット中のＺｎ量が多くなりフィレットの電位は管体表面やフィンの電位より卑となってしまう。また、フィンの電位をより卑にすると、フィンの自己腐食量が増大してフィンの消耗が著しくなるという問題がある。
【0032】
この問題を解消し、フィレットの電位を管体表面やフィンの電位に出来るだけ近づける手段について検討を行った結果、フィン材のろう材にＣｕを添加することにより、フィン

材の自己腐食を増大することなく、管体表面に均一なＺｎ被覆層を形成した場合にも、フィレットの電位を貴にすることができることを見出した。更に試験検討を重ねた結果、フィレットの電位はアルミニウム管体表面のＺｎ被覆量とフィン材の組成に影響されることがわかり、Ｚｎ被覆アルミニウム管体のＺｎ付着量をＡ（ｇ／ｍ^2）、フィン材の芯材中のＺｎ量をＢ％、ろう材中のＣｕ量をＣ％としたとき、－１００≦－１０×Ａ＋２３×Ｂ－１０６×Ｃ≦２０の関係を満足し、アルミニウム管体の内周部（管体の表面を外周部としたとき管体の内周部、すなわち管体の厚さ方向の最下部）の自然電位とフィンの自然電位との差（管体の内周部の自然電位－フィンの自然電位）を８０ｍＶ以上とした場合に、フィンの離脱現象が格段に改善されることを究明した。

【0033】

（－１０×Ａ＋２３×Ｂ－１０６×Ｃ）の値が－１００より小さい場合には、フィレットとフィンの電位差が大きくなり、フィレットが優先的に腐食して、早期にフィンの離脱が生じる。（－１０×Ａ＋２３×Ｂ－１０６×Ｃ）の値が２０を越える場合には、フィンの離脱現象が生じないが、フィンが優先的に腐食して熱交換性能がきわめて早期に低下する。また、アルミニウム管体の内周部の自然電位とフィンの自然電位との差が８０ｍＶ未満では、フィンの犠牲陽極効果が十分に発揮されず、アルミニウム管体の腐食深さが大きくなりやすく、短期間で貫通腐食が発生し、熱交換器としての機能が損失する。

【0034】

本発明のブレージングフィン材は、ブレージングフィン材を構成するための所定の組成を有する芯材用アルミニウム合金およびろう材用アルミニウム合金を、例えば、半連続鋳造により造塊し、常法に従って均質化処理を行った後、ろう材については、さらに熱間圧延を行い、均質化処理後の芯材と熱間圧延後のろう材をクラッドして、熱間圧延、焼鈍、冷間圧延、あるいは熱間圧延後冷間圧延して、焼鈍、仕上げ冷間圧延を経て製造され、厚さ０．１０ｍｍ（１００μｍ）以下の板材とする。この板材を所定幅にスリッティングした後、コルゲート加工して、作動流体通路材（チューブ材）、例えば、ＪＩＳ３００３合金などのＡｌ－Ｍｎ系合金で構成した偏平管偏平管と交互に積層し、ろう付け接合することにより、熱交換器コアとする。

【実施例】

【0035】

以下、本発明の実施例を比較例と対比して説明する。これらの実施例は本発明の一実施態様を示すものであり、本発明はこれに限定されるものではない。

連続鋳造により、表１に示す組成を有する芯材用アルミニウム合金およびろう材用アルミニウム合金（組合せＮｏ．Ａ～Ｔ）を造塊して、常法に従って均質化処理し、ろう材用アルミニウム合金鋳塊についてはさらに熱間圧延して、芯材用アルミニウム合金鋳塊の両面にクラッドした後、熱間圧延、ついで冷間圧延を行い、中間焼鈍を施した後、最終冷間圧延を経て、最終的に、表１に示すろう材クラッド率を有する厚さ０．０８ｍｍのクラッドフィン材（Ｈ１４調質材）を製造した。

【0036】

得られたフィン材について、コルゲート成形加工を行い、表面に１０μｍの厚さでＺｎを溶射した純アルミニウム系の多孔偏平管（５０段）からなるチューブ材に組付けて、予め嵌合部を設けたヘッダタンクおよびサイドプレートと組合わせ、フッ化物系のフラックスを吹き付けた後、６００℃（到達温度）に加熱して不活性雰囲気ろう付けを行った。

【0037】

【表1】

組合せ	芯材					ろう材		片面クラッド率 %
	Mn	Fe	Si	Zn	その他	Si	Cu	
A	1.6	0.15	0.5	2.5		10	0.2	10
B	2.5	0.15	0.5	2.5		10	0.2	10
C	0.9	0.15	0.5	2.5		10	0.2	10
D	1.2	0.15	0.85	2.5		10	0.2	10
E	1.2	0.15	0.15	2.5		10	0.2	10
F	1.2	0.08	0.5	2.5		10	0.2	10
G	1.2	0.25	0.5	2.5		10	0.2	10
H	1.2	0.15	0.5	3.5		10	0.2	10
I	1.2	0.15	0.5	1.0		10	0.2	10
J	1.2	0.15	0.5	2.5	Zr0.1	10	0.2	10
K	1.2	0.15	0.5	2.5	Cr0.1	10	0.2	10
L	1.2	0.15	0.5	2.5	Ti0.1	10	0.2	10
M	1.2	0.15	0.5	2.5	Zr0.1 Cr0.1	10	0.2	10
N	1.2	0.15	0.5	2.5		7.5	0.2	10
O	1.2	0.15	0.5	2.5		12.5	0.2	10
P	1.2	0.15	0.5	2.5		10	0.08	10
Q	1.2	0.15	0.5	2.5		10	0.35	10
R	1.2	0.15	0.5	2.5		10	0.2	5
S	1.2	0.15	0.5	2.5		10	0.2	17
T	1.2	0.15	0.5	2.5		10	0.2	10

《表注》組成：mass%

【0038】
芯材とろう材の組合わせＮｏ．Ａ～Ｔの試験材について、Ｈ１４材の機械的性質、フィンのコルゲート加工性、ろう付け後のコアの状態、ろう付け接合後のフィン、フィンとチューブの接合フィレットおよびチューブ表面の自然電位、コアの腐食試験後におけるフィンとチューブのフィン接合残存率、接合部の溶融座屈の有無、耐粒界腐食性、フィン材と接合されたチューブ材の耐孔食性を、以下の方法により評価した。結果を表２、表３に示す。

【0039】
Ｈ１４材の機械的性質：Ｈ１４材からＪＩＳ５号試験片を作製して引張試験を行い、０．２％耐力、引張強さおよび伸びを測定した。
フィンのコルゲート加工性：Ｈ１４材のコイルを２０ｍｍ幅に条切断し、フィン成形機を用いてコルゲート成形を行い、正常に成形できたものを○、肌あれ、微小割れなどの異常が生じたものを△として判定した。
ろう付け後のコアの状態：組付けたコアをろう付け加熱し、形成されたコアについてフ

ィンが座屈しているかどうかを目視で判定し、座屈が生じていないものは○、座屈を生じたものは×とした。
ろう付け接合後のフィン、フィンとチューブの接合フィレットおよびチューブ表面の自然電位：ろう付け加熱後のコアを切断し、各測定部のみを露出させ、他の部位を樹脂でマスキングした試料を作製し、酢酸でｐＨを３に調整した５％ＮａＣｌ水溶液中に２４時間浸漬して、飽和カロメル電極（ＳＣＥ）に対する電位を測定した。
【0040】
電位関係式の算出：偏平管表面のＺｎ付着量Ａ（ｇ／ｍｍ^2 ）、フィン芯材中のＺｎ濃度Ｂ％、フィンろう材中のＣｕ量Ｃ％から、（－１０×Ａ＋２３×Ｂ－１０６×Ｃ）を計算した。
接合部の溶融座屈の有無：接合部の代表部分を採取して、樹脂に埋め込み、接合部が溶融座屈しているかどうかを観察した。
【0041】
耐粒界腐食性：フィンとチューブを接合してなるコアについて、ＳＷＡＡＴ腐食試験（ＡＳＴＭ　Ｇ８５－８５）を４週間行った後、フィンの上下のチューブをつかんで引張試験を行って破断強度を測定し、その平均強度をフィン材の耐粒界腐食性判断の指標とした。
チューブ材の耐孔食性：上記の腐食試験でチューブに生じた最大孔食深さを測定して評価した。
フィンの接合残存率：上記の腐食試験後、フィンを機械的に切除し、フィンの接合率を下式により算出した。
フィン接合残存率（％）＝腐食試験後のフィン接合率／腐食試験前のフィン接合率
【0042】

【表2】

試験材	組合せ	H14 機械的性質		フィン成形性	チューブのZn付着量	コアの座屈	電位関係式の値	自然電位(mVSCE)			
		引張強さ MPa	耐力 MPa		g/mm²			フィレット	フィン	チューブ表面	チューブ内周部
1	A	220	210	○	10	○	-64	-892	-865	-792	-720
2	B	235	220	○	10	○	-64	-892	-850	-792	-720
3	C	185	175	○	10	○	-64	-892	-880	-792	-720
4	D	210	200	○	10	○	-64	-892	-880	-792	-720
5	E	185	175	○	10	○	-64	-892	-860	-792	-720
6	F	195	185	○	10	○	-64	-892	-874	-792	-720
7	G	195	185	○	10	○	-64	-892	-874	-792	-720
8	H	195	185	○	10	○	-41	-895	-895	-792	-720
9	I	195	185	○	10	○	-98	-877	-838	-792	-720
10	J	195	185	○	10	○	-64	-892	-874	-792	-720
11	K	195	185	○	10	○	64	-892	-874	-792	-720
12	L	195	185	○	10	○	-64	-892	-874	-792	-720
13	M	195	185	○	10	○	-64	-892	-874	-792	-720
14	N	190	180	○	10	○	-64	-905	-880	-792	-720
15	O	200	190	○	10	○	-64	-885	-870	-792	-720
16	P	195	185	○	10	○	-51	-915	-905	-792	-720
17	Q	210	200	○	10	○	-80	-870	-845	-792	-720
18	R	195	185	○	10	○	-64	-892	-874	-792	-720
19	S	205	195	○	10	○	-64	-892	-874	-792	-720
20	H	195	185	○	15	○	-91	-978	-895	-823	-720
21	T	195	185	○	7	○	-34	-880	-874	-785	-720
22	T	195	185	○	3	○	6	-850	-875	-775	-720
23	Q	210	200	○	4	○	-20	-840	-845	-780	-720

【0043】

【表3】

試験材	組合せ	電位差		フィン接合残存率	チューブ最大腐食深さ	SWAAT 試験後の平均破断強度
		（フィン）－（フィレット）	（チューブ内周部）－（フィン）	%	mm	MPa
1	A	27	145	90	0.06	49
2	B	42	130	85	0.07	54
3	C	12	160	95	0.04	46
4	D	12	160	90	0.06	47
5	E	32	140	80	0.04	45
6	F	18	154	90	0.04	46
7	G	18	154	90	0.06	48
8	H	0	175	100	0.04	42
9	I	39	118	80	0.08	51
10	J	18	154	90	0.05	47
11	K	18	154	90	0.05	46
12	L	18	154	90	0.05	48
13	M	18	154	90	0.05	46
14	N	25	160	80	0.06	44
15	O	15	150	95	0.07	45
16	P	10	185	70	0.04	53
17	Q	25	125	100	0.09	42
18	R	18	154	70	0.06	46
19	S	18	154	90	0.05	45
20	H	83	175	70	0.07	41
21	T	6	154	90	0.06	53
22	T	-25	155	100	0.05	56
23	Q	-5	125	100	0.05	48

【0044】

表２にみられるように、本発明に従う試験材Ｎｏ．１～２３はいずれも、フィン成形が優れ、ろう付け後のコアの座屈も無く、腐食試験後のフィンの接合残存率も７０％以上と良好であり、チューブの最大孔食深さは０．１ｍｍ未満の優れた耐孔食性を示した。また、ＳＷＡＡＴ試験後の平均破断強度も４０ＭＰａ以上であり、良好な耐粒界腐食性を示した。

【比較例１】

【0045】

連続鋳造により、表４に示す組成を有する芯材用アルミニウム合金およびろう材用アルミニウム合金（組合せＮｏ．ａ～ｑ）を造塊して、常法に従って均質化処理し、ろう材用

アルミニウム合金鋳塊についてはさらに熱間圧延して、芯材用アルミニウム合金鋳塊の両面にクラッドした後、熱間圧延、ついで冷間圧延を行い、中間焼鈍を施した後、最終冷間圧延を経て、最終的に、表４に示すろう材クラッド率を有する厚さ０．０８ｍｍのクラッドフィン材（Ｈ１４調質材）を製造した。

【0046】

得られたフィン材について、実施例１と同様に、コルゲート成形加工を行い、表面にＺｎ処理を施した純アルミニウム系の多孔偏平管（５０段）からなるチューブ材に組付けて、予め嵌合部を設けたヘッダタンクおよびサイドプレートと組合わせ、フッ化物系のフラックスを吹き付けた後、６００℃（到達温度）に加熱して不活性雰囲気ろう付けを行った。

【0047】

【表4】

組合せ	芯　材					ろう材		片面クラッド率 %
	Mn	Fe	Si	Zn	その他	Si	Cu	
a	0.5	0.15	0.5	2.5		10	0.2	10
b	2.9	0.15	0.5	2.5		10	0.2	10
c	1.2	0.15	0.05	2.5		10	0.2	10
d	1.2	0.15	1.3	2.5		10	0.2	10
e	1.2	0	0.5	2.5		10	0.2	10
f	1.2	0.35	0.5	2.5		10	0.2	10
g	1.2	0.15	0.5	0.6		10	0.2	10
h	1.2	0.15	0.5	4.4		10	0.2	10
i	1.2	0.15	0.5	2.5	Zr0.4	10	0.2	10
j	1.2	0.15	0.5	2.5	Cr0.4	10	0.2	10
k	1.2	0.15	0.5	2.5	Ti0.4	10	0.2	10
l	1.2	0.15	0.5	2.5		4	0.2	10
m	1.2	0.15	0.5	2.5		15	0.2	10
n	1.2	0.15	0.5	2.5		10	0.02	10
o	1.2	0.15	0.5	2.5		10	0.6	10
p	1.2	0.15	0.5	2.5		10	0.2	2
q	1.2	0.15	0.5	2.5		10	0.2	30

《表注》組成：mass％

【0048】

芯材とろう材の組合せＮｏ．ａ～ｑの試験材について、実施例１と同じ方法で、Ｈ１４材の機械的性質、フィンのコルゲート加工性、ろう付け後のコアの状態、ろう付け接合後のフィン、フィンとチューブの接合フィレットおよびチューブ表面の自然電位、コアの腐食試験後におけるフィンとチューブのフィン接合残存率、接合部の溶融座屈の有無、耐粒界腐食性、フィン材と接合されたチューブ材の耐孔食性を評価した。結果を表５、表６に示す。

【0049】
【表5】

試験材	組合せ	H14 機械的性質 引張強さ MPa	耐力 MPa	フィン成形性	チューブのZn付着量 g/mm^2	コアの座屈	電位関係式の値	自然電位(mVSCE) フィレット	フィン	チューブ表面	チューブ内周部
24	a	110	90	△	10	×	-64	-892	-900	-792	-720
25	b	--	--	--	--	--	--	--	--	--	--
26	c	130	110	△	10	×	-64	--	--	--	--
27	d	190	180	○	10	×	-64	--	--	--	--
28	e	195	185	○	10	○	-64	-892	-874	-792	-720
29	f	200	190	○	10	×	-64	--	--	--	--
30	g	195	185	○	10	○	-107	-883	-807	-792	-720
31	h	195	185	○	5	○	30	-900	-930	-792	-720
32	i	--	--	--	--	--	--	--	--	--	--
33	j	--	--	--	--	--	--	--	--	--	--
34	k	--	--	--	--	--	--	--	--	--	--
35	l	175	165	○	10	○	-64	--	--	--	--
36	m	--	--	--	--	--	--	--	--	--	--
37	n	195	185	○	10	○	-45	-922	-926	-792	-720
38	o	225	210	○	10	○	-106	-830	-770	-792	-720
39	p	190	180	○	10	○	-64	--	--	--	--
40	q	200	190	○	10	×	-64	--	--	--	--

【0050】

【表6】

試験材	組合せ	電位差		フィン接合残存率	チューブ最大腐食深さ	SWAAT 試験後の平均破断強度
		（フィン）－（フィレット）	（チューブ内周部）－（フィン）	%	mm	MPa
24	a	-8	180	--	--	42
25	b	--	--	--	--	--
26	c	--	--	--	--	--
27	d	--	--	--	--	--
28	e	18	154	90	0.09	48
29	f	--	--	--	--	--
30	g	76	87	30	0.15	55
31	h	-30	210	100	0.04	15
32	i	--	--	--	--	--
33	j	--	--	--	--	--
34	k	--	--	--	--	--
35	l	--	--	--	--	--
36	m	--	--	--	--	--
37	n	-4	206	20	0.08	52
38	o	60	50	100	0.18	10
39	p	--	--	--	--	--
40	q	--	--	--	--	--

【0051】

表５，６に示すように、試験材Ｎｏ．２４は芯材のＭｎ量が少ないため、フィンの引張強さが低くフィン成形性が劣る。試験材Ｎｏ．２５は芯材のＭｎ量が多いため、鋳造時の粗大な化合物が生じて圧延加工性が害され健全なフィン材の製造ができなかった。試験材Ｎｏ．２６は芯材のＳｉ量が少ないため、フィン材の引張強さが低くフィン成形性が劣る。試験材Ｎｏ．２７は芯材のＳｉ量が多いため、ろう付け接合部に局部溶融に起因する座屈が生じた。試験材Ｎｏ．２８は芯材のＦｅ量が少ないため、フィンの強度が低く、ろう付け時に座屈が生じた。試験材Ｎｏ．２９は芯材のＦｅ量が多いため、ろう付け後の芯材の結晶粒径が小さくなり、芯材の結晶粒界に溶融ろうが浸透してフィンに座屈が生じた。

【0052】

試験材Ｎｏ．３０は芯材のＺｎ量がすくないため、犠牲陽極効果が十分でなく、チューブ材に深い孔食が生じた。試験材Ｎｏ．３１は芯材のＺｎ量が多く、電位関係式の値が適正範囲を越えるため、フィン自体の腐食が大きくなった。試験材Ｎｏ．３２、Ｎｏ．３３およびＮｏ．３４は、それぞれ芯材のＺｒ量、Ｃｒ量およびＴｉ量が多いため、鋳造時に粗大な化合物が生成して圧延加工性が害され、健全なフィン材の製造ができなかった。

【0053】

試験材Ｎｏ．３５はろう材のＳｉ量が少ないため、流動するろうの量が不十分となって

接合性が劣り、腐食試験ができなかった。試験材Ｎｏ．３６はろう材のＳｉ量が多いため、圧延加工で材料の切断が生じた。試験材Ｎｏ．３７はろう材のＣｕ量が少ないため、フィレットが優先的に腐食してフィン接合残存率が低下した。試験材Ｎｏ．３８はろう材のＣｕ量が多いため、フィンに粒界腐食が生じ、腐食試験後にフィンがぼろぼろになった。試験材Ｎｏ．３９はろう材のクラッド率が低いため、流動するろうの量が不十分となり接合性が劣り、腐食試験ができなかった。試験材Ｎｏ．４０はろう材のクラッド率が高いため、ろうの溶融量が多く芯材が浸食された結果、接合部で座屈が生じた。

【産業上の利用可能性】

【0054】

本発明の熱交換器用アルミニウム合金ブレージングフィン材を使用し、ろう付けにより熱交換器を組立てた場合、熱交換器が腐食環境下に置かれてもフィンの離脱の問題を生じることがなく、フィンの犠牲陽極効果やチューブ表面の防食効果も十分に発揮されるため、熱交換器の長寿命化が達成される。